

wherein

said torque calculating unit obtains an average value of said two pairs of said magnetic sensors during passing of each of said plural targets to set a corrective gain with which each output is multiplied so as to make coincide the outputs of the two sets of said magnetic sensors with said average value.

28. (currently amended) A rotational angle detecting device, comprising:

a rotational member;

a target being provided on said rotational member;

first detecting means disposed to face said target so as to output a detection signal according to a rotation of said rotational member; and

second detecting means disposed to face said target so as to output a detection signal whose phase is different from the detection signal outputted by said first detecting means by a predetermined electrical angle and for detecting a displacement angle in a direction of rotation of said rotational member based on the detection signals outputted by said first detecting means and said second detecting means, said rotational angle detecting device further comprising:

first judging means for judging whether ~~each of~~ the detection signal outputted by said first detecting means and the detection

signal outputted by said second detecting means is greater or less than a substantially middle value between maximum and minimum values to be taken by said detection signals;

second judging means for judging a ~~relation in~~ magnitude relationships between the detection signal outputted by said first detecting means and the detection signal outputted by said second detecting means; and

third judging means for judging magnitude ~~magnitudes of~~ differences between each of said detection signals outputted by said first detecting means and said second detecting means and said substantially middle value,

wherein the displacement angle in the direction of rotation of said rotational member is detected based on results of judgments by said first judging means, said second judging means, and said third judging means.

29. (withdrawn) The rotational angle detecting device as set forth in claim 28, wherein said targets are magnetized so that magnetic poles reverse at substantially equal intervals in a circumferential direction of said rotational member.

30. (original) The rotational angle detecting device as set forth in claim 29, wherein a plurality of said targets are provided with a space therebetween in a circumferential direction of said

a steering assist electric motor driven and controlled based on a steering torque applied to said steering wheel;

a second shaft interlocked with said electric motor; and

said torque detecting device of claim 33 for detecting a steering torque applied to said first shaft, based on a torsional angle generated in a connecting shaft connecting said first shaft and said second shaft.

35. (original) A rotational angle detecting device comprising:

detecting means for detecting a position of a target and outputting a detection signal according to the detected position;

a rotational member on which said target is provided so that the detection signal changes according to a rotation; and

angle calculating means for calculating a rotational angle of said rotational member based on the detection signal multiplied by a gain, said rotational angle detecting device further comprising:

means for detecting a maximum value and a minimum value of the detection signal multiplied by said gain;

means for calculating a difference between the detected maximum value and minimum value; and

gain correcting means for correcting said gain so that the calculated difference is equal to a preset reference difference.

36. (previously presented) The rotational angle detecting device as

set forth in claim 35, further comprising:

means for calculating a ratio of said calculated difference to said reference difference; and

means for calculating a corrective gain by multiplying a preset reference gain by said calculated ratio, wherein

said gain correcting means corrects said gain to said corrective gain.

37. (original) The rotational angle detecting device as set forth in claim 35, wherein said target is provided on said rotational member so that a distance between said target and said detecting means changes according to a rotation.

38. (original) The rotational angle detecting device as set forth in claim 35, wherein said target is made of protrusions provided at substantially equal intervals in a circumferential direction of said rotational member.

39. (withdrawn) The rotational angle detecting device as set forth in claim 35, wherein said target is made of non-dent portions between dents formed at substantially equal intervals in a circumferential direction of said rotational member so as to create the non-dent portions.

40. (withdrawn) The rotational angle detecting device as set forth

in claim 35, wherein said target is magnetized so that magnetic poles reverse at substantially equal intervals in a circumferential direction of said rotational member.

41. (withdrawn) The rotational angle detecting device as set forth in claim 35, wherein said target comprises a first inclining portion provided to incline in one direction on a circumferential surface of said rotational member, and a second inclining portion provided to incline in other direction on the circumferential surface of said rotational member.

42. (original) The rotational angle detecting device as set forth in claim 35, wherein said detecting means comprises first detecting means and second detecting means, juxtaposed in a direction of rotation of said rotational member, for outputting detection signals having a phase difference.

43. (previously presented) The rotational angle detecting device as set forth in claim 42, further comprising:

first judging means for judging whether or not each of the detection signals of said first detecting means and second detecting means is higher than a first threshold greater than a detection signal value obtained when detection signal waveforms of said first detecting means and second detecting means crossed each

48) (currently amended) A rotational angle detecting device comprising:

detecting means for detecting a position of a target and outputting a detection signal according to the detected position;

a rotational member on which said target is provided so that the detection signal changes according to a rotation; and

angle calculating means for calculating a rotational angle of said rotational member based on the detection signal multiplied by a gain, said rotational angle detecting device further comprising:

means for detecting a maximum value and a minimum value of said detection signal;

means for calculating an average value of the detected maximum value and minimum value; and

offset correcting means for correcting said detection signal so that the calculated average value is equal to a preset reference average value.

49. (original) The rotational angle detecting device as set forth in claim 48, further comprising means for calculating a difference between said calculated average value and said reference average value,

wherein said offset correcting means adds said difference to said detection signal value so that the calculated difference becomes zero.

50. (original) A rotational angle detecting device, comprising first detecting means and second detecting means, wherein

one or a plurality of targets are provided on a rotational member so that said first detecting means outputs a detection signal according to a rotation of said rotational member,

said second detecting means outputs a detection signal whose phase is different from the detection signal of said first detecting means, and

a rotational angle of said rotational member is detected based on the detection signals outputted by respective said first detecting means and said second detecting means.

51. (currently amended) The rotational angle detecting device as set forth in claim 50, further comprising:

judging means for judging a relation in magnitude between detection signals outputted by said first detecting means and said second detecting means respectively in a previous cycle of sampling and a relation in magnitude between detection signals outputted by said first detecting means and said second detecting means respectively in this cycle of sampling;

judging means for judging whether the detection signal outputted by said first detecting means or said second detecting

means in this cycle of sampling is greater or less than a substantially middle value between maximum and minimum values to be taken by said detection signals; and

judging means for judging whether or not each of the detection signals outputted by said first detecting means and said second detecting means in this cycle of sampling is within a predetermined range, ~~whereby~~

wherein a displacement angle in a direction of rotation of said rotational member is detected based on results of judgments by said respective judging means.

52. (original) The rotational angle detecting device as set forth in claim 51, wherein said targets are made of protrusions provided at substantially equal intervals in a circumferential direction of said rotational member.

53. (withdrawn) The rotational angle detecting device as set forth in claim 51, wherein said targets are made of non-dent portions between dents that are formed at substantially equal intervals in a circumferential direction of said rotational member so as to form said non-dent portions.

54. (withdrawn) The rotational angle detecting device as set forth in claim 51, wherein said targets are magnetized so that magnetic

poles reverse at substantially equal intervals in a circumferential direction of said rotational member.

55. (withdrawn) The rotational angle detecting device as set forth in claim 51, wherein said target comprises a first inclining portion arranged to incline in one direction on a circumferential surface of said rotational member, and a second inclining portion arranged to incline in other direction on the circumferential surface of said rotational member, wherein said first inclining portion and said second inclining portion are magnetized.

56. (withdrawn) The rotational angle detecting device as set forth in claim 51, wherein said first inclining portion and said second inclining portion are substantially line symmetrical about a straight line passing through a connected point between said first and second inclining portions in an axial direction of said rotational member.

57. (currently amended) The rotational angle detecting device as set forth in claim 51, further comprising:

selecting means for selecting either of said first detecting means and second detecting means and either of an increasing state and a decreasing state of a detection signal value to be outputted

by said detecting means, based on results of judgments by said respective judging means, ~~whereby~~

wherein a displacement angle in a direction of rotation of said rotational member is detected based on the detecting means and the state of the detection signal value selected by said selecting means in the previous cycle of sampling and the detection signals outputted by said selected detecting means in the previous cycle of sampling and this cycle of sampling, respectively.

58. (currently amended) A torque detecting device comprising said rotational angle detecting device of claim 57 for each of a first shaft and a second shaft which are connected by a connecting shaft, ~~whereby~~

wherein a torque applied to said first shaft is detected based on a difference between detection signals outputted by said first detecting means or said second detecting means of each of said rotational angle detecting devices due to torsion generated in said connecting shaft.

59. (currently amended) The torque detecting device as set forth in claim 58, further comprising:

sign judging means for judging a sign of each of the difference between the detection signals outputted by said first

a second shaft connected to a steering mechanism;

a connecting shaft connecting said first shaft and said second shaft; and

said torque detecting device of claim 63 for detecting a steering torque applied to said first shaft, based on a torsional angle generated in said connecting shaft, ~~whereby~~

wherein steering is assisted according to the steering torque detected by said torque detecting device.

65. (original) A torque detecting device comprising:

two sets of one or a plurality of targets provided on a rotational member and one or a plurality of detecting means, disposed at separate positions in a direction of a rotational shaft of said rotational member, for outputting signals continuously according to a rotation of said rotational member; and

a torque calculating unit for calculating a rotational torque applied to said rotational member, based on the signals outputted by said detecting means respectively,

wherein said torque calculating unit comprises correcting means for calculating an average value of the signals outputted by said detecting means while said targets are passing positions facing said detecting means and for correcting said signals outputted by said detecting means to coincide with the average value.

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other;

second judging means for judging whether or not each of the detection signals of said first detecting means and second detecting means is lower than a second threshold smaller than a detection signal value obtained when the detection signal waveforms of said first detecting means and second detecting means crossed each other; and

third judging means for judging whether or not the detection signal waveforms of said first detecting means and second detecting means cross each other,

wherein the maximum value and minimum value of said detection signal are detected based on results of judgments made by said first, second and third judging means.

44. (original) A torque detecting device, comprising:

said rotational angle detecting devices of claim 43, provided for each of a first rotating shaft and a second rotating shaft which are coaxially connected to each other; and

torque calculating means for calculating a torque applied to said first rotating shaft, based on a difference between rotational angles detected by said rotational angle detecting devices.

45. (original) A torque detecting device, comprising:

said rotational angle detecting devices of claim 43, provided

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for each of a first rotating shaft and a second rotating shaft which are coaxially connected to each other; and

torque calculating means for calculating a torque applied to said first rotating shaft, based on a difference between rotational angles detected by said rotational angle detecting devices; wherein

when both the first detecting means and both the second detecting means of said rotational angle detecting devices detected the maximum values, the maximum values are made valid, while when both the first detecting means and both the second detecting means detected the minimum values, the minimum values are made valid.

46. (previously presented) The torque detecting device as set forth in claim 45, further comprising:

temperature detecting means for detecting temperature of said first detecting means and second detecting means;

storing means for storing a temperature detected by said temperature detecting means when the maximum value or the minimum value of each of the detection signals of said first detecting means and second detecting means was detected; and

means for calculating a difference between the temperature detected by said temperature detecting means and the temperature stored in said storing means and comparing the calculated difference with a predetermined value when said angle calculating means calculates a rotational angle,

temperature detecting means for detecting temperature of said first detecting means and second detecting means;

storing means for storing a temperature detected by said temperature detecting means when the maximum value or the minimum value of each of the detection signals of said first detecting means and second detecting means was detected; and

means for calculating a difference between the temperature detected by said temperature detecting means and the temperature stored in said storing means and comparing the calculated difference with a predetermined value when said angle calculating means calculates a rotational angle_L[[;]]

wherein when the difference is greater than the predetermined value, the calculation of said angle calculating means is prohibited.

47. (original) A steering apparatus, comprising:

a first rotating shaft connected to a steering wheel;

a second rotating shaft connected coaxially to said first rotating shaft and connected to a steering mechanism;

said torque detecting device of claim 46, for detecting a steering torque applied to said first rotating shaft; and

an electric motor for assisting a rotation of said second rotating shaft, based on the steering torque.

by said detecting means, based on results of judgments by said respective judging means, ~~whereby~~

wherein a displacement angle in a direction of rotation of said rotational member is detected based on the detecting means and the state of the detection signal value selected by said selecting means in the previous cycle of sampling and the detection signals outputted by said selected detecting means in the previous cycle of sampling and this cycle of sampling, respectively.

58. (currently amended) A torque detecting device comprising said rotational angle detecting device of claim 57 for each of a first shaft and a second shaft which are connected by a connecting shaft, ~~whereby~~

wherein a torque applied to said first shaft is detected based on a difference between detection signals outputted by said first detecting means or said second detecting means of each of said rotational angle detecting devices due to torsion generated in said connecting shaft.

59. (currently amended) The torque detecting device as set forth in claim 58, further comprising:

sign judging means for judging a sign of each of the difference between the detection signals outputted by said first

detecting means and the difference between the detection signals outputted by said second detecting means; and

first comparing means for comparing magnitudes of the detection signals outputted by said first detecting means and second detecting means on said first shaft side when said sign judging means judged that the signs of said differences were identical, ~~whereby~~

wherein a torque applied to said first shaft is detected based on a result of comparison by said first comparing means.

60. (currently amended) The torque detecting device as set forth in claim 59, further comprising second comparing means for comparing magnitudes of a substantially middle value between maximum and minimum values to be taken by the detection signals and each of the detection signals outputted by said first detecting means and second detecting means on said first shaft side when said sign judging means judged that the signs of said differences were different, ~~whereby~~

wherein a torque applied to said first shaft is detected based on a result of comparison by said second comparing means.

61. (currently amended) The torque detecting device as set forth in claim 60, further comprising:

first judging means for judging whether or not at least one of the detection signals outputted by said first detecting means is out of a predetermined range;

second judging means for judging whether or not at least one of the detection signals outputted by said second detecting means is out of a predetermined range; and

third comparing means for comparing magnitudes of an absolute value of a difference between the detection signals outputted by said first detecting means and an absolute value of a difference between the detection signals outputted by said second detecting means, ~~whereby~~

wherein a torque applied to said first shaft is detected based on a result of comparison by said second comparing means, a result of judgment by said first judging means, a result of judgment by said second judging means, and a result of comparison by said third comparing means.

62. (currently amended) The torque detecting device as set forth in claim 61, further comprising:

abnormality detecting means for detecting abnormality of detection signals outputted by each of a pair of said first detecting means and a pair of said second detecting means; and

means, when an abnormality was detected in one of said detection signals by said abnormality detecting means, for making a

difference between the detection signals outputted by the pair of detecting means including the detecting means which outputted an abnormal detection signal zero, $[[;]]$ whereby

wherein, when there is one abnormal detection signal, a torque applied to said first shaft is detected without using said one detection signal.

63. (currently amended) The torque detecting device as set forth in claim 62, further comprising:

storing means for storing the detection signals outputted by said first detecting means and said second detecting means and preset detection signals to be outputted according to each of the detection signals outputted by said first detecting means and said second detecting means, in association with each other; and

means for outputting said detection signals to be outputted, based on the detection signals outputted by said first detecting means and said second detecting means and contents stored in each of said storing means, whereby

wherein detection signals outputted by said means are made detection signals outputted by said first detecting means and said second detecting means, respectively.

64. (currently amended) A steering apparatus comprising:

a first shaft connected to a steering wheel;

a second shaft connected to a steering mechanism;
a connecting shaft connecting said first shaft and said second shaft; and

said torque detecting device of claim 63 for detecting a steering torque applied to said first shaft, based on a torsional angle generated in said connecting shaft, ~~whereby~~

wherein steering is assisted according to the steering torque detected by said torque detecting device.

65. (original) A torque detecting device comprising:

two sets of one or a plurality of targets provided on a rotational member and one or a plurality of detecting means disposed at separate positions in a direction of a rotational shaft of said rotational member, for outputting signals continuously according to a rotation of said rotational member; and

a torque calculating unit for calculating a rotational torque applied to said rotational member, based on the signals outputted by said detecting means respectively,

wherein said torque calculating unit comprises correcting means for calculating an average value of the signals outputted by said detecting means while said targets are passing positions facing said detecting means and for correcting said signals outputted by said detecting means to coincide with the average value.